Rev. Soc. Entomol. Argent. 54 (1-4): 89-96, 1995

LIFE TABLES OF THE SOYBEAN LOOPER *RACHIPLUSIA NU* (LEPIDOPTERA: NOCTUIDAE) IN THE LABORATORY*

SANCHEZ, Norma E. and Patricia C. PEREYRA****

ABSTRACT. Three initial cohorts of eggs of *R. nu* were held under laboratory conditions. Survivorship (l_x) and fecundity (m_x) were determined every 24 h until adults died. Age-specific and stage-specific survival and fecundity curves were constructed. Mean developmental time of stages was calculated. The following population parameters were computed: net reproductive rate (Ro), intrinsic rate of increase (r), finite rate of increase (λ), generation time (T), and reproductive values (V_x). There were moderate differences in age-specific survival and fecundity curves between cohorts. Stage-specific survival curves showed an important overlapping of stages. Mean total fecundity ranged between 813.75 and 1,438 eggs/female. Oviposition period ranged between 6 and 12 days. Higher reproductive values occurred between days 31 and 40. *R. nu* showed a high potential for increase under this study's conditions. Mean Ro, mean r, mean λ, and mean T values were: 531.45, 0.19, 1.21, and 33.24, respectively.

RESUMEN. Tablas de vida de la oruga medidora *Rachiplusia nu* (Lepidoptera: Noctuidae) en el laboratorio. A partir de tres cohortes de huevos de *R. nu*, mantenidas bajo condiciones de laboratorio, se estimó la supervivencia (l_x) y la fecundidad (m_x) cada 24 horas, hasta la muerte de los adultos. Se construyeron curvas de supervivencia y fecundidad específicas por edad y por estado. Se calculó la duración media de cada estado y se computaron los siguientes parámetros poblacionales: tasa reproductiva neta (Ro), tasa intrínseca de incremento (r), tasa finita de incremento (λ), tiempo generacional (T) y valores reproductivos (V_x). Se encontraron diferencias moderadas en las curvas de supervivencia y fecundidad específicas por edad entre cohortes. Las curvas específicas por estado mostraron una importante superposición de estados. La fecundidad promedio total alcanzó valores entre 813,75 y 1.438 huevos/hembra. El período de oviposición se extendió entre 6 y 12 días. Los valores reproductivos más altos ocurrieron entre los días 31 y 40. *Rachiplusia nu* mostró un gran potencial de incremento bajo las condiciones de este estudio. Los valores promedio de Ro, r, λ y T fueron: 531,45; 0,19; 1,21 y 33,24, respectivamente.

---

* Scientific Contribution no. 238 of the Centro de Estudios Parasitológicos y de Vectores (CEPAVE).
** Centro de Estudios Parasitológicos y de Vectores (CEPAVE), calle 2 nro. 584, 1900 La Plata, Argentina.

INTRODUCTION

Rachiplusia nu (Guenée) is a major soybean defoliator in the Southern Hemisphere. In Argentina, it is especially important in Buenos Aires province (Aragón & Belloso, 1987; Gamundi, 1990), where it undergoes two generations on soybean during each growing season (pers. observ.). There is some information about natural enemies (parasites and predators) (Margheritis & Rizzo, 1965; Aragón, 1979), chemical control (Bimboni, 1974; Parissi *et al.*, 1979), and nutritional ecology (Pereyra, 1994) of this pest, but nothing concerning its population ecology.

In order to contribute with valuable information to the management of this pest, the objective of this study was the construction of life tables and the estimation of population parameters of this species in the laboratory.

MATERIAL AND METHODS

Larvae of *R. nu* were collected in a pasture of *Melilotus* sp. (Leguminosae) in Los Hornos, Buenos Aires province (Argentina). They were reared in the laboratory until adults emerged and eggs were laid. Three cohorts of 23, 21, and 17 eggs (cohorts A, B, and C) were placed individually in Petri dishes of 10 cm diameters, with moistened filter paper and held at 25 ± 1° C and a photoperiod of 14:10 (L:D). Larvae were fed every day with fresh soybean leaves, *Glycine max* (Merrill) var. Hood, until pupation. Individuals were sexed during fourth larval instar and once pupated, one of each sex was transferred to plastic cylinders (9.5 cm diameter, 23 cm height). Adults were fed with a sucrose solution (15%) and were kept in the cylinders, the inner surface of which was covered with a black construction paper for oviposition.

Cohort survivorship (proportion of the initial population alive at age x) and fecundity (mean number of offspring produced per female of age x) were estimated every 24 hours and data were compiled in a life table. Age-specific (in days) survival (l_x) and fecundity (m_x) curves were constructed using only the female portion of the population. Total mean fecundity was estimated for each cohort as the mean number of offspring produced by the females during their entire lifetime. Mean developmental time (days) of stages and stage mortality were also calculated.

Moreover, stage-specific (egg, larva, prepupa, pupa, and female and male adult) survival curves were constructed. These curves represent the proportion of the initial population present in each stage every day, and include variable development rates among individuals and the male population as proposed by Chi & Liu (1985) and Chi (1988), as well as the duration of the stages.

From age-specific survival (l_x) and fecundity (m_x) schedules, the following population parameters were computed: intrinsic rate of increase (r), finite rate of increase (λ), net reproductive rate (Ro), mean generation time (T), and reproductive value (V_x) (Pianka, 1983). Intrinsic rate of increase (r) which is the instantaneous rate of change of population size per individual and finite rate of increase (λ), which is the rate of increase per individual per unit time, were calculated by Newton's method (Hadeler, 1982) in Lotka's equation.

$$\sum_{x=1}^{w} \exp(-rx)\, l_x\, m_x = 1$$

where x is the age class, w is the oldest of the age classes, and l_x and m_x as defined above.

(Ro), defined as the mean number of female offspring produced by one female during its entire life span, was calculated by the equation:

$$Ro = \sum_{x=1}^{w} l_x m_x$$

Generation time (T), defined as the average time between two successive generations, was calculated by the equation:

$$T = \frac{\sum_{x=1}^{w} x\, l_x m_x}{Ro}$$

Reproductive value (V_x), defined as the contribution to the future population that one female of age x will make, was calculated by:

$$V_x = \frac{\exp r\,(x - 1)}{l_x} \sum_{y=x}^{w} \exp(-ry)\, l_y m_y$$

where y is any age class between x and w.

RESULTS AND DISCUSSION

Mean duration of stages of *R. nu* are shown in Table I. A low variability among individuals was observed. From this table, an average life span of approximately 37 days for females and 36 days for males, can be calculated. Age-specific survival and fecundity are illustrated in figure 1 A, B, and C. Curve C shows a high initial survival, decreasing abruptly from day 34, curve B decreases smoothly along cohort development, and curve A is intermediate between B and C. Mean duration of cohorts was 42, 37, and 41 days, for cohorts A, B, and C respectively.

Total mean fecundity was 813.75 eggs/female for cohort A, 1,438 eggs/female for B, and 831.75 eggs/female for C. Fecundity schedule had one peak at day 31-32

Table I. Mean duration of stages of *R. nu* under laboratory conditions (25 ± 1° C and photoperiod of 14 L: 10 D).

	Egg	Larva	Prepupa	Pupa	Adult female	Adult male
Mean	3.5	16.36	1.63	7.51	8.00	7.35
Standard deviation	0.0	1.92	0.70	0.79	2.62	1.28
(n)	(44)	(33)	(33)	(33)	(19)	(14)

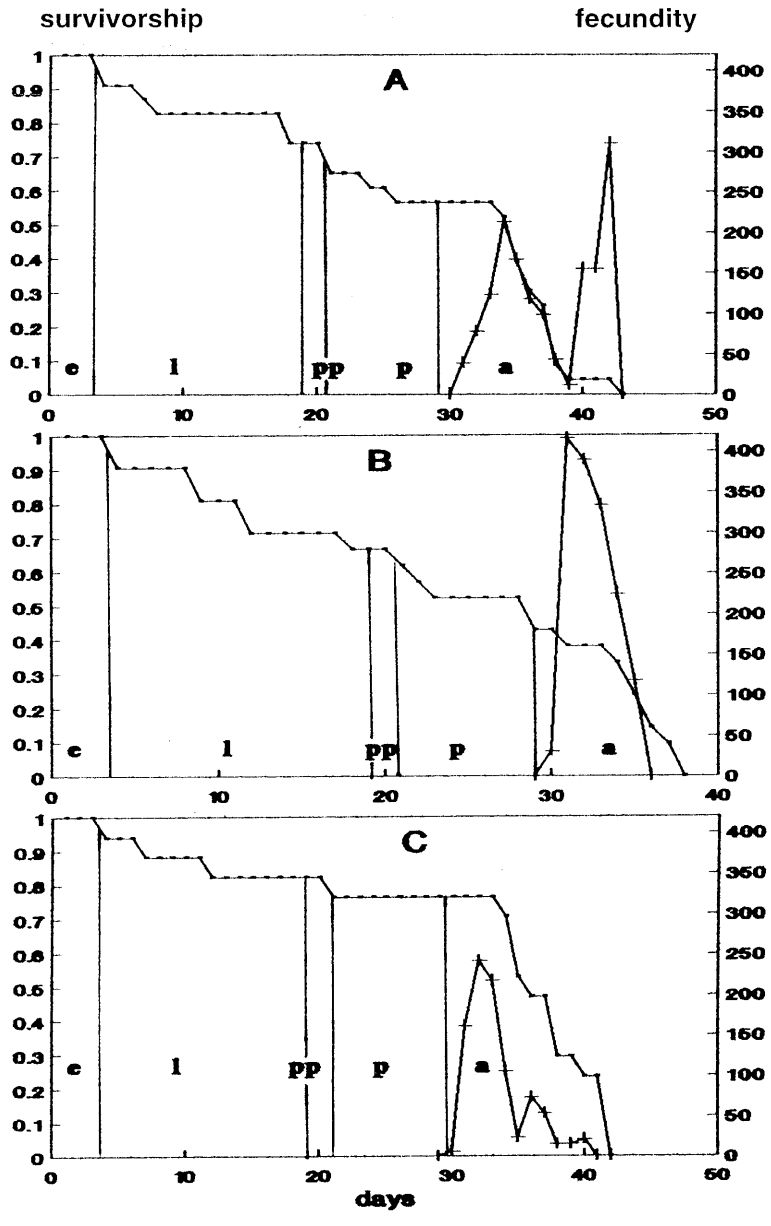

Fig. 1. Age-specific survival (l_x) and fecundity (m_x) curves of cohorts A, B, and C. Mean duration of each stage are indicated (e: egg, l: larva, pp: prepupa, p: pupa, a: adult female). —•— survivorship,—+— fecundity.

for cohort B and C, and two, one at day 34 and the other at day 42 for cohort A. Oviposition period lasted 12 days for cohorts A and C, and 6 days for cohort B. According to Fitt (1989), high fecundity is common to many Noctuids (*e. g. Spodoptera* and *Heliothis*). Chen & Hsiao (1984) recorded a fecundity ranging between 1,218 and 1,587 eggs/female in *Spodoptera litura* and Reed (1965) recorded up to 3,000 eggs/

Table II. Stage mortality of *R. nu* under laboratory conditions (25 ± 1° C and photoperiod of 14 L : 10 D).

Cohort	Egg	Larva	Prepupa	Pupa	Adult
A	0.087	0.381	0	0	0.532
B	0.095	0.579	0	0	0.326
C	0.059	0.250	0	0	0.691

female in *Heliothis armigera*. The maximun fecundity recorded in *R. nu* under the conditions of this study was 1,547 eggs/female, which is similar to that recorded by Chen & Hsiao (1984) for *S. litura*.

Stage mortalities were higher during larval and adult stage, ranging between 25 and 58% in larvae and between 33 and 69% in adults. Only in cohort B mortality during larval stage was higher than in the adult stage. Mortality in egg stage was lower than 10% and there was no mortality in prepupae and pupae (Table II).

An important stage overlapping was observed in stage-specific survival curves (Fig. 2 A, B, and C). This variation added to the short duration of prepupal stage determines lower survival values in prepupal stage than in pupal stage, in the three cohorts. Considering that the overlapping stages are common in field populations and that both male and female are economically important, the stage-specific survival curves are more realistic and more appropriate for practical application in pest management than age-specific curves, where the means of each stage are used to divide the life span into stages (Table I and Fig. 1 A, B, and C). Reproductive values curves (V_x) (Fig. 3 A, B, and C) showed that the higher contribution to the next generation occurs at the age of 31 days in cohort B and C, and at 31 and 40 days in cohort A. Maximum reproductive value for the three cohorts was 907.80 (cohort B) corresponding to the second day of adult female life.

Life table statistics for *R. nu* are presented in Table III. Mean sex ratios (male: female) were higher for female, mainly during adult stage. The high proportion of individuals surviving to the adult stage, combined with a high fecundity and a short generation time gives *R. nu* a high biotic potential under the conditions of this study. High values of Ro, r and λ, determined a high capacity for population increase. Cohort C had the highest value. Ro values calculated in *R. nu* ranged between 404.95 and

Table III. Life table parameters and sex ratios of *R. nu* under laboratory conditions (25 ± 1° C and photoperiod of 14 L : 10 D).

Cohort	Ro	r	λ	T	sex ratio	
					IV larval instar	adult
A	404.95	0.1761	1.190	34.50	1:0.89	1:1.17
B	550.14	0.1961	1.220	32.32	1:1.60	1:3.00
C	639.26	0.1980	1.220	32.91	1:1.00	1:1.00
Mean	531.45	0.1900	1.210	33.24	1:1.16	1:1.72
Standard deviation	118.27	0.0120	0.017	1.13	0.38	1.10

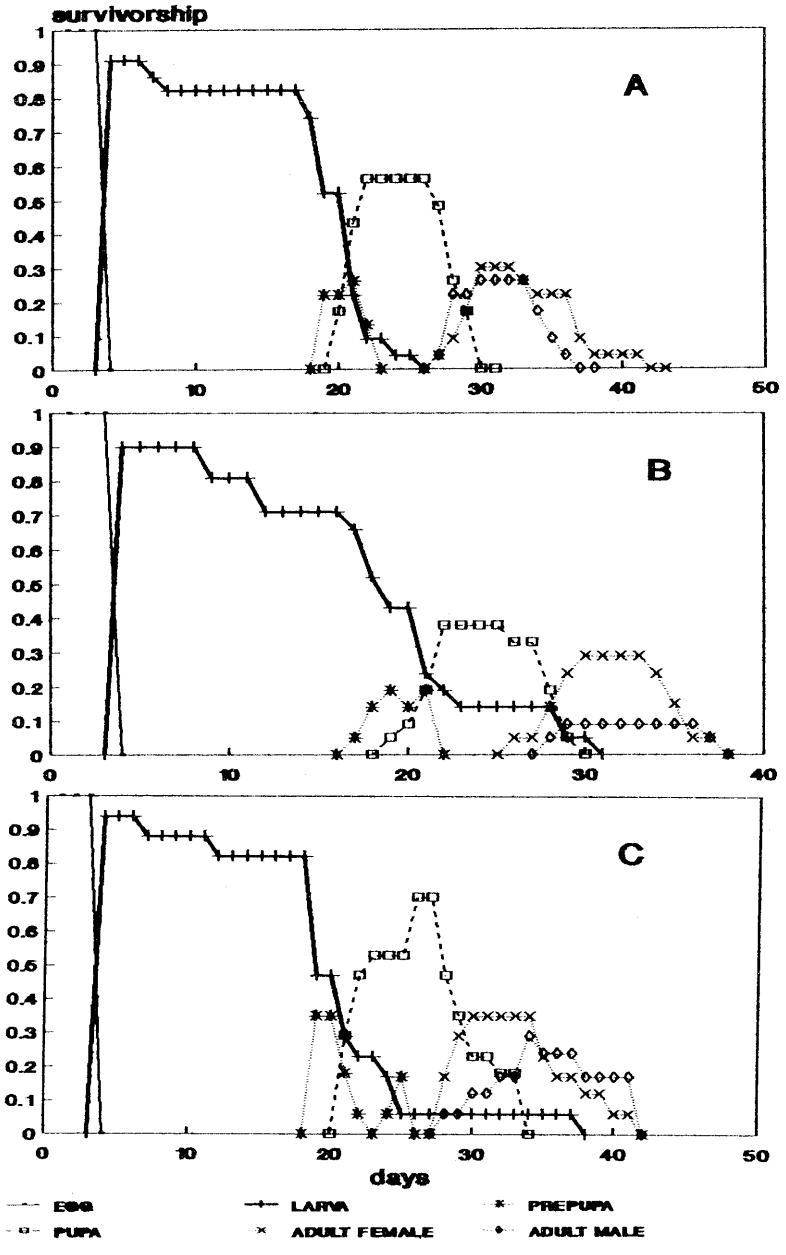

Fig. 2. Stage-specific survival curves (proportion of the initial population present in each stage every day) of cohorts A, B, and C.

639.26 and were higher than those determined by Chen & Hsiao (1984) in *Spodoptera litura*, which ranged between 262.62 and 405.91. Average r and λ values of 0.19 and 1.21 respectively were estimated in this study for *R. nu*, and are also higher than in any other Lepidopterous pest. Bessin & Reagan (1990) reported mean values of 0.12

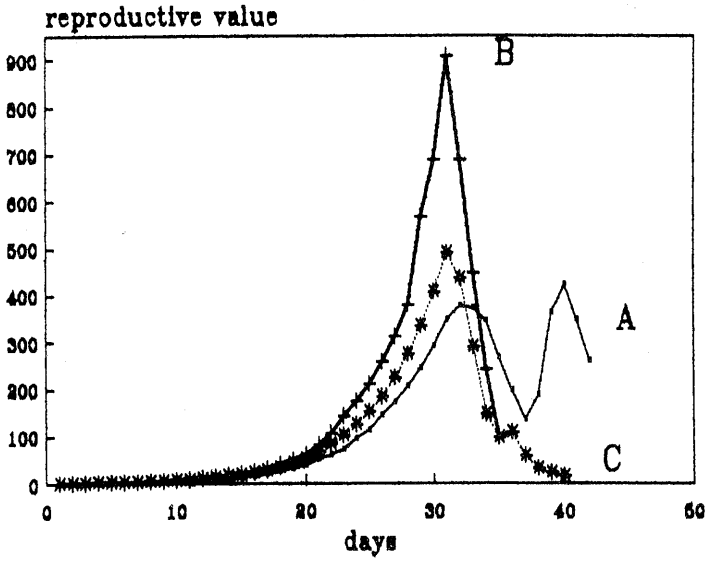

Fig. 3. Reproductive value (V_x) curves of cohorts A, B, and C.

and 1.13 for the same parameters respectively for the sugarcane borer *Diatraea saccharalis* collected from different varieties of sugar cane.

Results of this study suggest that overlapping stages added to the extended oviposition period, would make prediction of seasonal occurrence of life stages, optimal sample scheduling and timing of control measures difficult in natural populations of *R. nu*. Population parameters presented in this paper should be valuable in future development of phenology and population dynamics models to assist entomologists in pest management programs.

LITERATURE CITED

ARAGON, J. R. 1979. Grave ataque de orugas en soja en las provincias de Córdoba y Santa Fe. *Circ. Ext. INTA Marcos Juárez* Nro. 37, 5 pp.

ARAGON, J. R. & C. A. BELLOSO. 1987. Control de plagas. *En:* Producción de soja. Cuadernos de actualización técnica AA-CREA, Nro. 41: 68-82.

BESSIN, R. T. & T. E. REAGAN. 1990. Fecundity of sugar cane borer (Lepidoptera: Pyralidae), as affected by larval development on gramineous host plants. *Environ. Entomol.* 19: 635-639.

BIMBONI, H. G. 1974. Informe preliminar del ensayo de control químico de la isoca medidora del girasol en el cultivo de soja. EEA INTA San Pedro, 2 pp.

CHEN, C. N. & W. F. HSIAO. 1984. Influence of food and temperature on life history traits and population parameters of *Spodoptera litura* Fabricius. *Plant Prot. Bull. (Taiwan, R. O. C.)* 26: 219-229.

CHI, H. 1988. Life-table analysis incorporating both sexes and variable development rates among individuals. *Environ. Entomol.* 17: 26-34.

CHI, H. & H. LIU. 1985. Two new methods for the study of insect population ecology. *Bull. Inst. Zool. Acad. Sinica* 24: 225-240.

FITT, G. P. 1989. The ecology of *Heliothis* species in relation to agroecosystems. *Annu. Rev. Entomol.* 34: 17-52.

GAMUNDI, J. C. 1990. *Control integrado de insectos plaga en el cultivo de soja.* Jornada de actualización profesional sobre cultivos de cosecha gruesa. Soja. INTA, pp. 16-20.

HADELER, K. P. 1982. *Matemáticas para biólogos.* Ed. Reverté, Barcelona.

MARGHERITIS, A. E. & H. F. RIZZO. 1965. *Lepidópteros de interés agrícola.* Sudamericana, Buenos Aires.

PARISSI, R., N. IANNONE & M. C. ZANELLI. 1979. Control químico de la isoca medidora *Rachiplusia nu* (Guen.) (Lepidoptera, Noctuidae) en el cultivo de soja. Carpeta de producción vegetal EERA INTA, Pergamino, 3 pp.

PEREYRA, P. C. 1994. Efecto de la edad de las hojas de soja sobre el crecimiento y la reproducción de *Rachiplusia nu* (Lepidoptera, Noctuidae). *Ecología Austral* 4: 41-47.

PIANKA, E. R. 1983. *Evolutionary Ecology.* Harper & Row Publ., New York.

REED, W. 1965. *Heliothis armigera* (Hb.) (Noctuidae) in western Tanganyika. I. Biology with special reference to the pupal stage. *Bull. Entomol. Res.* 56: 117-125.

Recibido: 12-III-1994
Aceptado: 10-VIII-1994